COMPASS

perspectives & tools to benefit southern forest resources

Winter 2005

The Biomass Challenge

What are we going to do with all that wood?

Southern Research Station

USDA Forest Service

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COMPASS
Science You Can Use!

Winter 2005 — Volume 1, Number 1

perspectives & tools to benefit southern forest resources

Cover photo by Les Groom is a confocal microscope image of how resin (orange) adheres to individual wood fibers (green). These images are used to analyze processes for making composite building materials such as fiberboard.

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(Photo by Warren Gretz, NREL)

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DEPARTMENTS

Compass is a quarterly publication of the USDA Forest Service Southern Research Station (SRS). As part of the Nation's largest forestry research organization—USDA Forest Service Research and Development—SRS serves 13 Southern States and beyond. The Station's 130 scientists work at more than 20 units located across the region at Federal laboratories, universities, and experimental forests.

SRS scientists are involved in a wide range of scientific disciplines (from hydrology to wildlife biology to genetics) and sustain a strong track record of cooperative research with scientists from other organizations. Current research adds to a history of long-term multiple-scale studies that cross ownership boundaries to provide knowledge and information about the forests of the southern region.

Future issues can be obtained by returning the postcard included in this issue.

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WHAT ARE WE GOING TO DO WITH ALL THAT WOOD?

When Hurricane Charley hit central Florida in August 2004, the storm left over 1.5 million cubic yards of downed trees and limbs in Orange County alone. Officials estimated that it would take 200,000 dump truck loads to remove the wood to rural incineration sites to be ground up and burned. Hurricanes Ivan and Jeanne left millions of additional tons of wood down in cities and on public lands across the Southeast. Though some of the wood will be salvaged, millions of tons will end up as waste. What if this wood could be used to fuel a nearby power plant? What if the fiber could be processed into super strong building materials, or "cooked" into biofuels for cars? Perhaps some day all of these options will be available; for now, most of the wood waste from hurricanes and other disasters ends up in landfills or is ground into mulch.

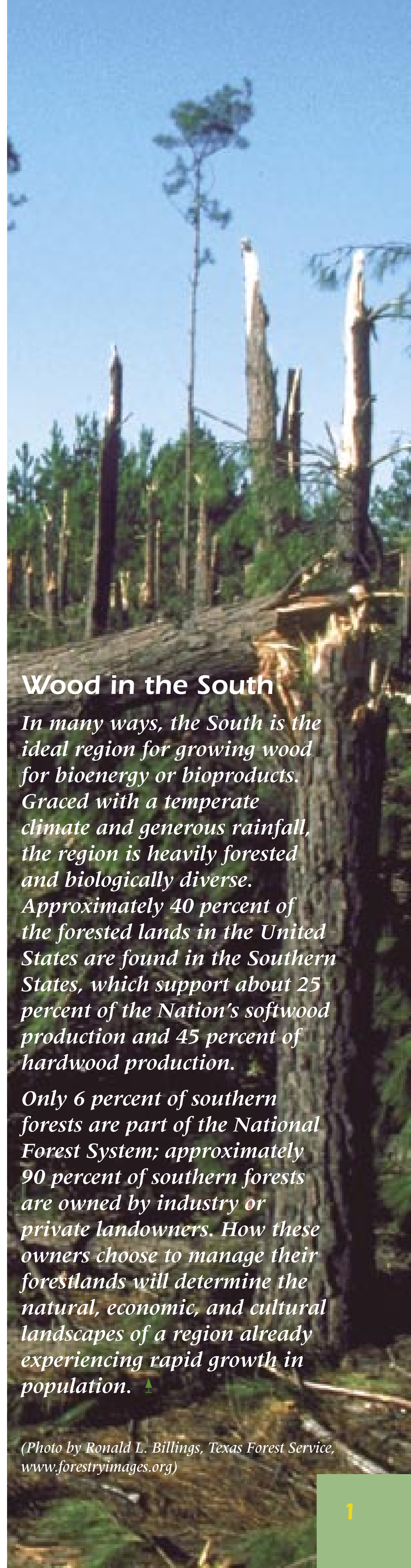
The **USDA Forest Service** faces a similar situation, though on a much larger scale. Years of suppressing fire in national forests has led to a dense growth of small trees and brush, raising the risk of wildfire and making forests more susceptible to insect pests and pathogens. Under the Healthy Forests Restoration Act (HFRA) signed into law in December 2003, Federal agencies will remove millions of tons of wood—most of it small diameter (less than 9 inches across)—to reduce the risk of wildfire and improve the health of individual trees. Meanwhile, declines in pulpwood markets have resulted in mill closings across the country, and most timber operators are not interested in harvesting only small diameter wood. To attract the contractors needed to thin forests, there must be viable markets for small diameter wood.

The writers of the HFRA were well aware of this dilemma. Section 201 of the Act authorizes $22 million for research focused on overcoming barriers to the wider use of small diameter wood. Section 202 authorizes funds to help build community-based forest enterprises in rural areas, while a third section supports grants to owners or operators of facilities using wood as a raw material for powerplant-produced energy, transportation fuels, or other biobased products.

...the greatest barrier to bioenergy lies in the logistics and costs of cutting, handling, and transporting small diameter wood. Generating electric power requires large quantities of biomass. If an energy plant is designed to be run strictly on biomass, there must be enough material available to run the plant year-round...

In August 2004, the USDA and the U.S. Department of Energy (DOE) awarded $25 million in research funding to develop bioenergy sources and biobased products. The **Southern Research Station (SRS)** and partners received two $1 million grants. One grant will be used to develop ways to involve small landowners and businesses in growing, harvesting, and transporting biomass. The other will support research on harvesting small diameter wood, growing short rotation woody crops for bioenergy, and developing biobased products.

(continued on page 2)



Wood in the South

In many ways, the South is the ideal region for growing wood for bioenergy or bioproducts. Graced with a temperate climate and generous rainfall, the region is heavily forested and biologically diverse. Approximately 40 percent of the forested lands in the United States are found in the Southern States, which support about 25 percent of the Nation's softwood production and 45 percent of hardwood production.

Only 6 percent of southern forests are part of the National Forest System; approximately 90 percent of southern forests are owned by industry or private landowners. How these owners choose to manage their forestlands will determine the natural, economic, and cultural landscapes of a region already experiencing rapid growth in population.

(Photo by Ronald L. Billings, Texas Forest Service, www.forestryimages.org)

THE HEALTHY FORESTS RESTORATION ACT

On December 3, 2003, President Bush signed into law the Healthy Forests Restoration Act of 2003 (P.L. 108-148), which contains a variety of provisions to expedite hazardous fuel reduction and forest restoration projects on specific types of Federal land that are at risk of wildland fire or insect and disease epidemics. The act helps rural communities, States, Tribes, and landowners restore healthy forest and rangeland conditions on State, Tribal, and private lands. It also encourages biomass removal from public and private lands and directs the establishment of monitoring and early warning systems for insect or disease outbreaks.

For more information:

http://www.healthyforests.gov/initiative/introduction.html

(continued from page 1...)

New Approaches to an Old Energy Source

Wood, used for heat since early humans discovered fire, was the main source of U.S. energy until the early part of the 20th century, when oil and coal became dominant. Over the last few decades, as prices for nonrenewable fossil fuels have continued to rise, biomass (loosely defined as wood or plant material) has received more attention as a readily available, renewable energy source. In 2002, according to DOE statistics, biomass supplied 47 percent of all renewable energy in the United States—more than any other renewable source, including hydroelectric power.

Nationwide, thousands of facilities are already burning wood or wood waste to produce heat and generate electricity. Most of these facilities are industrial pulp and paper mills burning waste from their own operations. Some utilities co-fire wood with coal; these plants purchase wood waste from forest products industries or use urban wood residues such as pallets, construction and demolition waste, and landscape prunings. Co-firing involves replacing some of the coal with biomass, either by mixing the two fuels together or by using separate feed lines for the coal and wood. Depending on the boiler design, biomass can replace up to 15 percent of the coal fueling a power plant.

Newest on the block are gasification technologies that convert biomass to gases that are then used to generate heat and electricity. This technology is being tested now as a possible source of power for businesses, schools, and small communities: several companies have developed portable modules designed to power individual homes.

Advantages of Using Wood

By October 2004, oil prices had climbed past $50 a barrel, rising over 40 percent in the last year alone. Coal burning in the United States is set to increase by 50 percent by 2025, with coal prices projected to rise as productivity improvements slow. Using renewable energy sources such as wood provides a distinct advantage over using finite fossil fuels, especially when the benefits of reducing pollution and emissions of greenhouse gases are added in.

Using biomass for fuel helps reduce the carbon dioxide (CO_2) emissions have contributed to climate change. Plants remove carbon from the

(Photo by R. Kindlund)

atmosphere through photosynthesis: theoretically, if the carbon removed is balanced by the energy used, there is no net increase in CO_2. In reality, there are still CO_2 emissions associated with harvesting, processing and transporting biomass fuel, but these are relatively low. In contrast, burning coal, natural gas, and oil adds CO_2 to the atmosphere with no balancing process to remove it. Another advantage of using biomass as a fuel is the reduction in air pollution from the sulfur and nitrous dioxides that result from burning fossil fuel. Small diameter trees have less than 50 percent the nitrogen content of coal, and the sulfur content of wood is negligible. Using forest thinnings for fuel also prevents the wood from being burned in the open air with no pollution controls. Thinning forests also reduces the likelihood of forest fire, which affects air quality globally. Using the wood waste that usually ends up in landfills also reduces the amount of methane released into the atmosphere.

Barriers

With all of this wood available from thinning forests, why aren't we building more gasification plants?

Probably the greatest barrier to bioenergy lies in the logistics and costs of cutting, handling, and transporting small diameter wood. Generating electric power requires large quantities of biomass. If an energy plant is designed to be run strictly on biomass, there must be enough material available to run the plant year-round—and it must be close enough to the plant to be transported economically. Generally, if biomass fuel is transported more than 50 miles, all cost advantages are lost. At this time, transportation, storage, and handling costs push up the price of bioenergy production to the point where it is not competitive, though this will change as fossil fuel prices continue to rise.

Biomass gasification plants also have higher capital costs than fossil fuel plants, and power output efficiencies do not yet compete with those run on fossil fuels. The conversion of biomass heat to electricity is less efficient than the conversion rate of coal to electricity, mainly due to the high moisture content of wood sources. Again, advances such as "whole tree systems," which cut and dry entire trees in the field, promise to remove moisture content as a limiting factor, and gasification technology continues to advance.

Biomass and Bioenergy Terms

Biomass: *any organic matter available on a renewable basis. For our purposes, biomass can be small diameter trees and brush from forest thinning operations, wood residues (wood not harvested for bioenergy purposes, such as leftovers from lumber or pulp operations), short rotation woody crops planted to produce energy, or wood waste from demolition or other sources.*

Biobased product: *a commercial or industrial product (other than food or feed) made of renewable biological products such as forestry materials.*

Bioenergy: *energy derived from organic matter, whether directly from plants or indirectly from plant-derived industrial, commercial, forestry, or urban wastes.*

Bioenergy crops: *fast-growing crops grown to produce energy—traditionally poplar, willow, sweetgum, and cottonwood. Also referred to as energy feedstocks.*

Biofuels: *mostly liquid fuels for transportation produced from biomass and used instead of petroleum products. Examples include ethanol, methanol, and biodiesel.*

Biorefinery: *an integrated processing plant envisioned to "biorefine" biomass from multiple sources into chemicals, fibers, biofuels, pharmaceuticals, and other high-yield products.*

Carbon sequestration: *refers to the long-term storage of carbon on land (in trees and other plants), underground, or in oceans.*

Gasification: *the process of heating wood in an oxygen-starved chamber until the release of volatile gases that can then be combusted to produce heat and electricity.*

Renewable energy: *any energy source that can be replenished continuously or within a moderate timeframe.*

In this issue...

In addition to bioenergy, there are all sorts of other uses proposed for the small diameter wood thinned from our national forests. In this issue of Compass, we look at how SRS researchers are helping to remove the barriers to successfully using biomass for energy and for products. Examples include economical ways to get thinned wood out of the forest, to grow woody crops as feedstocks, to turn wood fiber into new building products and chemicals, and to recycle used wood. Intrinsic to all of these efforts is the idea that developing new markets that involve landowners and small business in thinning forests and planting trees is not only good for rural economies but also helps sustain the health of our southern forests.

(Photo by Trice Megginson, AU Photographic Services)

THINNING THE FOREST, BOOSTING LOCAL ECONOMIES

Forest fires in the Western United States have brought more and more attention to the crowded and overstocked conditions of the Nation's forests. Small trees growing close together in the understory of mature forests set the stage for catastrophic fires that can destroy whole stands of trees and lead to the loss of human life. By October 1, Federal agencies had exceeded their goal of removing hazardous fuels from 3.7 million acres of forestland for the period ending September 2004, but millions of acres remain untreated. Most of this fuel load consists of small trees, branches and brush—wood that is not of much value to traditional timber operators.

Over the last decade, researchers from the **Southern Research Station (SRS) forest operations unit** in Auburn, AL, have been working with small businesses interested in using small diameter wood thinned from public lands. "It is still difficult to make money from small diameter wood," says **Bob Rummer**, project leader of the unit. "We have done everything from helping businesses work out bids on thinning projects, to dealing with air quality in plant operations, to designing economical harvesting systems. Obviously, we can't respond to all the requests we get. We choose projects based on whether there is a researchable question."

"the ability to manage the biomass gives us a more robust way to manage the land."

The cost of transporting wood is a major barrier for small businesses. "It just isn't worth it if you have to truck it long distances," says Rummer. "Moving raw material from the forest to where it is used contributes about 50 percent to the cost of wood fiber. This proportion rises if the price of gas rises. Wood is not really competitive as an energy source unless you factor in the value of not using fossil fuels—and of improving the health of the forest and decreasing the risk of wildfire."

A Success Story

Rummer's unit has been working for several years with SBS Wood Shavings, a family business in New Mexico that processes small diameter pine trees thinned from the Lincoln National Forest into shavings for animal bedding. Owners Sherry and Glen Barrow emphasize sustainability in the design of all aspects of their operation and take pride in the fact that their shavings are a direct byproduct of forest restoration.

After setting up and automating their plant, SBS Wood Shavings began to bid on contracts to thin small diameter wood from national forest land. The company had several people cutting for them but no cost-effective way to transport the logs. Contacted through the New Mexico State Forester, the SRS unit helped estimate costs for the company's first thinning operation and evaluated the small-scale system their contractors were using to get the wood from the forest to the plant.

"Getting the logs out of the forest economically was a major problem for the company," says Rummer. "They needed logs cut a specific length—100 inches—before they could process them." Rummer's unit developed a custom rack system by updating a pallet rack system used in the South in the 1960s. SBS dropped the racks off where their contractors were thinning, returning to pick them up when they were full.

"We are now helping SBS and their contractors develop a new system that allows one person to do all the logging and loading using a harwarder, which is a combination of a harvester and forwarder," says Rummer. Developed to cut, take off limbs, and load the logs directly onto a hauler, the harwarder is also "light on the land." The long reach of the machine's boom means fewer skid trails in the logging area, which translates into less damage to soils, streams, and standing trees.

Bundle Up

This year, the SRS forest operations unit finished a research project in the Western United States to evaluate the slash bundler, another light-on-the-land machine designed to bundle the debris left after thinning operations. A recent inventory found that at least 110 million bone-dry tons of this material, commonly called slash, could be removed from high-risk stands in the West alone. The main barrier to using this material for energy is the cost of picking up and moving so many small pieces.

The slash bundler was originally developed to recover biomass in Finland, where some 20 percent of energy is produced by wood-burning plants. With its single giant claw, the machine grabs up piles of limbs, extruding them as Christmas tree-like bundles automatically wrapped with baling twine. Usually set to be extruded as 2 feet wide and 10 feet long residue logs, the bundles can be loaded, transported, and processed with conventional log handling equipment.

"The most common practice on national forests has been to burn slash on the site," says Rummer. "Burning slash has been shown to produce even more air pollution than wildfires and is not permitted on many of the sites that need to be thinned. Biomass bundling gives us a way to treat slash piles immediately after thinning."

The evaluation project tested the slash bundler on seven locations selected to reflect a range of conditions. Evaluation results showed the importance of using bundling as part of an integrated system of forest management. "Bundling is a good complement to low-impact thinning operations, since it provides an efficient way to remove slash with minimum impact on the soil and the remaining trees," says Rummer.

This type of machine works well with the new emphasis on using small diameter wood thinned from forests for energy, fiber, or other products. "These are exciting times for forest operations," says Rummer. "The ability to manage the biomass—whether that means bundling slash or helping small wood-based businesses work out logistical problems—gives us a more robust way to manage the land. There is no single treatment option for small diameter wood or slash that will meet the needs of all situations," he adds. "With millions of acres still needing attention, we need a range of tools to successfully fulfill the intent of the Forest Service in restoring the health of the national forests."

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CD Features Video of Slash Bundler in Action

Information from Bob Rummer's evaluation of the slash bundler is included on the CD, Forest Residues Bundling Project (0451-2C02-MTDC), now available from the Southern Research Station. The CD contains a full copy of the New Technology for Residue Removal Report in both HTML and Acrobat formats, and includes a 15-minute video of the study. A gallery of images suitable for use in PowerPoint presentations or for Web sites is also included.

To order the CD, send your name and complete mailing address with the title, Forest Residues Bundling Project, and publication number (0451-2C02-MTDC) to pubrequest@srs.fs.usda.gov.

To search SRS publications on the Web: http://www.srs.fs.usda.gov/pubs/index.htm

GOING MOBILE

SBS Wood Shavings, the small company featured in this article, is also a demonstration site for the BioMax 15, a prototype gasifier that can use forest thinnings to generate electricity and heat. The demonstration sites are part of a project started by the technical marketing unit of the USDA Forest Service ***Forest Products Laboratory (FPL)*** *in Madison, WI; the U.S. Department of Energy's National Renewable Energy Laboratory (NREL); and the Community Power Corporation (CPC), an NREL subcontractor who developed the prototype BioMax.*

Fully automated and transportable, the small biopower plant can produce 15 kilowatts of electricity and 50 kilowatts of heat and runs on a wide range of dry biomass feedstock. The feedstock is dumped into a dryer that uses excess heat produced by the unit itself, then fed into the top of the gasifier, where it combusts in oxygen-deprived conditions at approximately 800ºC (1,472ºF). The hydrogen and carbon monoxide gases produced power an internal combustion engine that generates electricity.

CPC recently moved into the product validation phase for the BioMax 15, which is not yet commercially available. The Forest Service has contributed $1 million over 2 years to speed the development of the BioMax project; CPC has installed the units at four sites near national forests where small diameter wood thinned for forest health is readily available. CPC plans to make BioMax units available commercially in mid-2005, with an estimated cost of $50,000 for a 20-kilowatt unit.

CPC has also developed a smaller unit for residential use, the BioMax 5, which uses about 100 pounds of wood pellets a day to power an average-sized house. FPL plans to install a BioMax 5 in their research demonstration house in Madison, WI, for testing, after which it will be shipped to Cameron, AZ, and installed in a traditional Navajo hogan.

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(Photo courtesy Forest Products Lab)

PREPARING FOR AN INVASION MAY GENERATE SOME HEAT

Healthy Forests Restoration Act Title IV: Insect Infestations and Related Diseases

Under the authority of Title IV of the Healthy Forests Restoration Act (HFRA), the USDA Forest Service has developed plans for six landscape-level research projects that specifically address insect infestations and diseases. Three of the six projects involve Southern Research Station (SRS) units:

- *In Kentucky, the gypsy moth and oak decline project in the Daniel Boone National Forest led by David Loftis, project leader of the Bent Creek, NC, unit (featured here)*
- *In Arkansas, the red oak borer in the Ozark and Ouachita Mountains project led by Jim Guldin, project leader of the Monticello, AR, unit*
- *In North Carolina, the hemlock woolly adelgid project led by Jim Vose, project leader of the Coweeta Hydrologic Laboratory in Otto, NC*

SRS units are also involved in four of seven accelerated information gathering efforts also set up under Title IV. These include treatment strategies to help public and private landowners recover from red oak borer in the Ozark Mountains, led by the Monticello, AR unit, and three projects from the insects and diseases unit in Athens, GA:

- *Evaluation of biological control agents for the hemlock woolly adelgid*
- *Trapping systems for exotic beetles and wood-boring insects*
- *Effects of wildfire and prescribed burning on bark beetles*

A major barrier to effectively thinning forests to improve health is finding markets for small diameter wood, which is not attractive to traditional timber contractors. In Kentucky, an experiment designed to help oak forests withstand a future invasion by the gypsy moth also provides an opportunity to evaluate methods for removing small wood from the forest for bioenergy uses.

Southern Research Station (SRS) researchers are working with the Daniel Boone National Forest in central Kentucky on a 600-acre silvicultural assessment that will test how well different thinning options reduce the vulnerability of oaks to the major gypsy moth attack expected within the next decade. Designed as a unique study under Title IV of the Healthy Forests Restoration Act (HFRA), the thinning options will also be evaluated for their effectiveness in reducing the oak decline already present in the forest.

Gypsy moths, introduced into the Boston area around 1869, have moved slowly but steadily down into the Southern Appalachian Mountains. The small populations of the pest found so far on the Daniel Boone have been eradicated, but the front line of the attack is not expected to reach the area for another 10 years. When it arrives, the moths will number in the millions per acre, infestation levels that can leave trees completely stripped of leaves. Individual oaks can recover from complete defoliation, but, depending on tree health, often die after several rounds of attacks.

Although the gypsy moth feeds on hundreds of plant species in North America, the insect prefers oaks, which, with the chestnut gone, are the most important trees in the Southern Appalachians. "Oaks make up the largest component of upland deciduous forests in the South," says **David Loftis,** project leader of the **SRS Bent Creek unit** and of the silvicultural assessment effort on the Daniel Boone. "Oaks are obviously important for timber, but they also serve as a main food source for numerous animals. Oak decline is already here, and the gypsy moth on the way. We will test a range of silvicultural alternatives specified in the forest plan for the Daniel Boone National Forest to address the vulnerability of oaks to these pests and diseases."

Studies using forest management to minimize the impact of the gypsy moth have been done before, but always when the forest was already infested. "We believe that the health of trees prior to the arrival of gypsy moth is critical," says **Bill Jones**, forest health protection scientist also working on the project. "This is the first study that attempts to preserve existing oaks by improving the health of the forest 10 years before the main attack. If this works, it will give forest managers across the Southeast another strategy to strengthen oaks within forests already stressed by other pests and poor stand conditions well before the arrival of the gypsy moth."

The oak regeneration experiment uses five different thinning options, also called treatments. The most intensive option, shelterwood with reserves, cuts all but the largest trees, promoting the sprouting and growth of a second group of trees by allowing more light to reach the ground. "You essentially create a two-aged stand, which will eventually grow into a forest with two canopies," says

Loftis. "Oaks will probably dominate, though there may be some shift towards non-oaks."

A second option uses the prediction models Loftis has developed to promote oak regeneration. The models allow forest managers to time the removal of trees to create conditions that promote the growth of oak seedlings into overstory trees. A third option combines thinning with prescribed burning, while a fourth involves thinning with no regeneration effort. The fifth treatment is a control, where nothing is done. Perhaps the largest experiment of its kind, the plots will also serve as demonstrations to show private forest landowners how to use silvicultural treatments to regenerate oak on their own land.

The Bioenergy Angle

With the exception of the first treatment, most of the trees thinned will be small diameter (2 to 12 inches). The National Forest is working with the East Kentucky Power Cooperative, which is interested in using the small diameter wood thinned from the experimental plots to generate electricity. One of the key questions is whether it will be cost effective to cut and haul this wood to a co-firing plant.

Bob Rummer, project leader of the **SRS forest operations unit**, will assess the costs of using the equipment needed to cut, stack, and haul wood based on the characteristics—slope, soil quality, and tree size—of each experimental site. "The shelterwood cut, as the most open, will be the easiest to operate in," says Rummer. "We will try to use whole-tree operations that fell the trees and take everything to the roadside for chipping. Some of the roads in the forest may not support chippers and chip transport, so we will also look at the costs of alternatives such as taking whole trees to an offsite wood yard for chipping."

East Kentucky Power, the first utility in Kentucky to use biodiesel in its trucks, would like to add energy from biomass to its EnviroWatts program. "We are in the very first stages of this project and don't know if it will be cost effective for the utility to use this wood," says Rummer. "This project will help us assess whether using forest thinnings for bioenergy is feasible for other sites. In calculating cost-effectiveness, we always need to consider the benefits to society gained from protecting forest health and investigating sustainable ways to replace fossil fuels."

For all the researchers involved, the ultimate question is how well different forest treatments can improve forest health. "The longer-term result of the planned treatments is the conversion of older to younger stands of trees," says Loftis. "We hope the change in age structure will have an impact on the vulnerability of the oak forests in the Daniel Boone National Forest to both gypsy moth and oak decline."

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Also working on the project are Callie Schweitzer from SRS, Kurt Gottschalk from the Northeastern Research Station, and Rex Mann and George Bain from the Daniel Boone National Forest.

Oak decline *is caused by a complex interaction among environmental stresses and pests. Trees weakened by drought, flood, and frost can be invaded and killed by insects and diseases that cannot successfully attack healthy trees. Usually the progression of decline is slow, occurring over several years, with the top dying back from the branches to the inner tree.*

From USDA Forest Service Forest Insect and Disease Leaflet 165. *http://www.na.fs.fed.us/spfo/pubs/fidls/oakdecline/oakdecline.htm*

The dominant tree in the Southern Appalachians, oak is threatened by oak decline and an array of pests. The silivicultural assessment is designed to promote oak regeneration and to improve individual tree health.

(Photo by Mary Ann Fajvan, West Virginia University, www.forestryimages.org)

LOCALLY GROWN POWER

...advantages of a locally grown wood supply are multiple. The power plant gains an economic and reliable fuel source. Idle agricultural land can be used to grow trees rather than cleared for development. Carbon is sequestered, soil stabilized, and water quality improved. Small landowners have a reliable cash crop—and ideally, consumers receive lower electric bills...

(USDA Forest Service photo)

Imagine that your local utility decides to install a biomass-run power plant or retrofit a coal-firing plant to burn wood with coal. The utility plans to use small diameter trees thinned to improve the health of nearby national forests, as well as wood waste from construction and other sources. What if these resources are not available in enough quantity within a 50-mile radius, the distance beyond which it is not cost effective to transport the biomass?

Over 5 million acres of land fall within a 50-mile radius of any particular point. In the South, depending on the location, this area could include a substantial number of acres in national, industrial, or private forests, all potential sources of thinned wood, yet the logistics of removing and transporting this wood are still problematic. Another way to solve the supply problem is to pay landowners near the plant to grow some or all of the feedstock. The advantages of a locally grown wood supply are multiple. The power plant gains an economic and reliable fuel source. Idle agricultural land can be used to grow trees rather than cleared for development. Carbon is sequestered, soil stabilized, and water quality improved. Small landowners have a reliable cash crop—and ideally, consumers receive lower electric bills.

"Using biomass for energy—whether it comes from forest thinning operations or from trees grown as crops—allows us to maintain the health of our forests," says **Mark Coleman**, biological scientist working on short rotation woody crops at the Savannah River site of the **Southern Research Station (SRS) unit in Charleston, SC**. "Basically, short rotation woody crops are fast-growing tree species such as poplar, cottonwood, and even loblolly pine that can be planted at relatively low cost and harvested on a rotating schedule, usually 5 to 15 years."

Successfully growing short rotation woody crops involves choosing the best site for each species, selecting superior plant material, preparing the site, dealing with pests and competing vegetation, fertilizing for maximum growth, and ensuring an adequate water supply. In calculating the benefits and costs of using trees for energy, the environmental impacts of using fertilizers, herbicides, and pesticides have to be taken into account—as well as the benefits of reducing erosion, improving water quality, and providing habitat for wildlife.

Finding the Best Tree For the Site

In 1996, researchers from SRS, timber companies, and other Federal agencies started the **Short Rotation Woody Crops Cooperative Research Program** to provide the data needed to establish and manage short rotation woody crops on different sites. "We are looking at the effect of site characteristics on how well different species grow, how management can affect growth and productivity rates, and how these intensively managed woody crops affect the environment," says Coleman, who started working with the program in 1998. "We are trying to determine whether growing these trees for bioenergy, fiber, and other uses is economically and ecologically favorable."

In 2000, Coleman and others started a large-scale experiment at the Savannah River Site to evaluate tree growth response in relation to site characteristics. On 95 large experimental plots, they planted five different types of trees—sycamore, sweetgum, loblolly pine, and two cottonwoods. Each plot is treated with different levels of water and nutrients. "In this experiment, we are looking at how different levels of irrigation and fertilization affect tree growth," says Coleman. "The objective is to identify the site conditions that lead to maximum growth for each species."

The data from these plots will provide site-specific information to pass on to both industry and the small landowner. "Although we have not yet harvested the first rotation, results so far show that all the species we planted grow faster with fertilization, though some species did not seem to need irrigation," says Coleman. "We planted two cottonwood clones, one from the Mississippi River Delta and the other from east Texas. The Texas clone grew just as large on the relatively dry Savannah River site without irrigation, showing that it is possible to get superior growth on dry sites."

Loblolly Pine Shows Promise

The loblolly pines in the experimental plots also did well without additional water. "Loblolly pine shows some of the best potential for bioenergy uses in the Southeast," says Coleman. "It is very well adapted for this region and is a species that industry has already planted all over the South. With the market for U.S. pulpwood declining, we're having a lot of discussions with industry about new markets for loblolly pine." Industry has been looking closely at the "biorefinery" concept, where harvested wood is taken to one location to be processed into pulp for paper, fuel for bioenergy, or feedstocks for bioproducts such as liquid fuels, composites, and polymers.

There are many ecological advantages of growing short rotation woody crops for fuel. "With their high yields, short rotation woody crops concentrate production on fewer acres, so natural forests can be managed for other purposes," says Coleman. Trees grown for energy can also be planted as buffer zones around wetlands and along rivers. These buffer strips help control erosion, filter runoff from farms and towns, and provide habitat for small mammals, birds, and insects. SRS researchers and others are also

(continued on page 10)

INCENTIVES & DISINCENTIVES

Renewable Portfolio Standard (RPS), also called a renewable energy standard, requires that a specific percent of a utility's generating capacity or energy sales be derived from renewable energy sources such as wind, solar, landfill gas, geothermal, and biomass. Some standards require that the utility reach a target percent by a certain year. Most RPSs are implemented at the State level but can be applied locally. By November 2004, 14 States had implemented minimum renewable energy standards, with three additional States in the process. Of the Southern States, only Texas has adopted an RPS.

For more information:
http://www.ucsusa.org/clean_energy/renewable_energy/page.cfm?pageID=114

Net metering uses a standard electric meter to record the flow of energy back and forth between an independent generator and the utility's power grid. Net metering laws allow people or companies generating electricity from renewable energy sources to connect to utility grids and to receive credit for the energy they produce.

Net billing agreements allow generators who produce more power than they consume to sell excess electricity to the utility at a fixed rate. In most areas, the utilities pay wholesale or "avoided cost" rates that are lower than the rates the utilities charge their customers for electricity. Most utilities also have limits on the size of the generator and the type of technology used.

For specific information on net metering and net billing by State and utility:
http://www.dsireusa.org/library/includes/seeallincentivetype.cfm?type=Net&currentpageid=7&back=regtab

(Photo by Warren Gretz, NREL)

(continued from page 9)

studying the ability of poplars and other fast-growing trees to pull hazardous waste from soil in a process known as phytoremediation.

So What's the Down Side?

In previous articles, we stressed that the success of the USDA Forest Service restoration efforts in national forests depends on developing markets for the small diameter wood thinned to reduce fire hazard and improve forest health. Landowners interested in growing short rotation trees for profit also need reliable markets before they commit land, time, and money to this new crop. Most trees planted as short rotation woody crops take 6 to 10 years to reach harvest size and must be replanted every rotation.

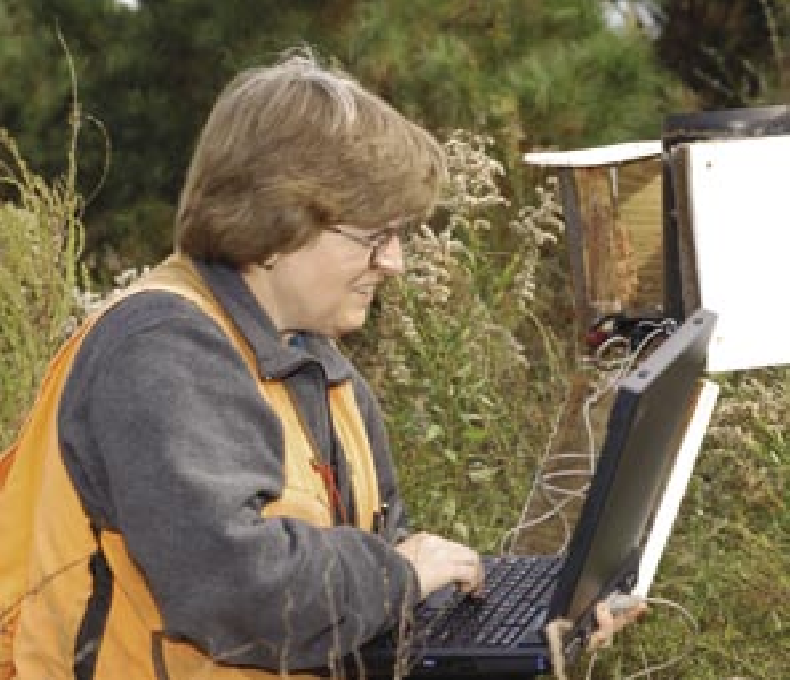
"If we want to use wood for energy in the South, we cannot presume any one supply source," says Coleman. "It's more realistic to think of a portfolio of possible suppliers that includes national forests, industry, and private landowners." The problems are not just logistical in the South, where very few States offer incentives to grow biomass for energy. "Leasing land, preparing the ground, planting, maintenance, and harvesting can cost the landowner $30 to $50 a ton, while power plants would like to pay $12 to $13 a ton for wood, so there is quite a disconnect at this time," says Coleman. "To really make this work, we have to make the price for power from renewable energy sources competitive with that from traditional sources, either through incentives such as renewable power standards, offsets for carbon sequestration or pollution controls, or by getting the power companies to pay retail rates to independent renewable power producers."

It can actually work. In Minnesota, where the State's largest utility is required to purchase 125 megawatts of energy from biomass sources alone, several biomass power plants are now up and running. Landowners have received incentives to grow short rotation woody crops, in this case hybrid poplars. Using hybrid stock, farmers have been able to increase their yield to 3 to 6 bone-dry tons per acre per year. Area power plants, under the mandate to use biomass for energy, are paying $55 to $75 per bone-dry ton. A 50-megawatt biomass plant, which can supply enough power for a city of 50,000, can use approximately 40,000 acres of poplars. Consultants predict that renting land to grow hybrid poplar for the bioenergy industry will become increasingly popular as the market becomes more robust.

Trees grow faster in the South than in Minnesota, fast enough to increase the number of bone-dry tons produced per acre."The forestry industry in the South is very efficient at both planting and harvesting trees," says Coleman. "Acres already in plantation forests or in food crops logically provide the best sites for short rotation woody crops. Our research is designed to provide the knowledge landowners and industry need to begin growing trees for energy. As oil prices continue to rise, the prices the power industry is willing to pay for biomass will become more competitive, and energy crops will become more attractive."

For more information:
Mark Coleman at (803-725-0513) or
mcoleman01@fs.fed.us

(Photos by Warren Gretz, NREL)



(Photo by Trice Megginson, AU Photographic Services)

SNAPSHOT
From the Field...

Emily Carter, research scientist at the Southern Research Station **(SRS) forest operations unit in Auburn, AL**, studies the impact of thinning and other forest operations on soil. With funding from the Joint Fire Science Program, Carter is collaborating with a wide range of partners—Auburn University, the University of Georgia, the Long Cane and Conecuh Ranger Districts, Alabama Power, and the SRS unit in Charleston, SC—on studies in Alabama and South Carolina that evaluate the impact of thinning operations on soil properties, including erosion, in three focus areas: longleaf pine, the wildland-urban interface, and sites where prescribed burning is also used.

We tracked Emily Carter down by phone and email to ask her questions about life as a research scientist.

How are the results of your current research used?

My results give forest managers specific information they can use to determine the risk of compaction and erosion from different harvesting and thinning practices. My work also helps other researchers understand the complicated relationships between soil, rain, and management activities that can contribute to erosion.

Why do you do research?

I've always been curious about the natural world and how it works. Research allows me to test the questions I pose to understand the natural world and how our activities impact it.

Where were you raised?

I usually tell people that I was raised in America because my Dad had a 23-year career in the Coast Guard before he went to teach oceanography for another 22 years. We lived in Los Angeles twice, San Diego, Miami, and Washington, DC, before my dad retired. We moved to Baltimore, Maryland, when he took a position at Johns Hopkins University.

What was your first experiment as a child?

I always had an interest in the outdoors, and developed early interests in geology and astronomy. I was lucky—I spent some of my formative years in Miami, which had a science museum with a very active summer education program. I spent many nights counting meteors, identifying constellations, looking for comets, and observing the moon and planets with my 2-inch reflector telescope. I conducted my first "real" experiments with the chemistry set I received for Christmas when I was 9. I experienced my first failed experiment when I tried to duplicate the composition of seawater to make a home for a starfish I found at the beach.

Who has been your most important mentor?

I don't remember any particular mentor, but rather sources of inspiration—my Dad, of course, and my supervisor when I worked as a lab technician in the geological oceanography department during high school and college.

What discovery or innovation has most changed your area of work?

The computer—not so much for my area, but for research in general. The computer has streamlined the process of publishing results by giving the researcher the ability to analyze data and produce a research paper on the desktop. When I started grad school, we produced our research products on IBM Selectric typewriters and made all of our graphs by hand.

What would you become if not a researcher?

I think I would have opted for a career in teaching or farming, although some people have told me I would be a good bartender.

Why a farmer?

My family farmed through my father's generation, so you could say that it's in my DNA. I find it immensely satisfying to grow a plant from a seed or a sapling using my understanding of the plant and local conditions, while hoping for Mother Nature to be kind in providing the proper weather conditions. I think it also speaks to an urge to be self-sufficient.

What's the best piece of advice you have received?

More to the point, the best piece of advice I've ignored—to find a job where the potential for economic return was higher than being a scientist.

What is the one thing about science you wish the public understood better?

The results of studies are often questioned as to their validity and relevance, but even the most absurd-sounding research can reveal information that is important or has application.

If you could put more money into one area of science, what would it be?

First, I would put more money into research, period. Second, I would put more money into educating people about the importance and relevance of the scientific information being uncovered, particularly as it relates to the sustainability of the natural systems we depend on.

What's around the corner?

Keep on researching.

FIBER FOR CONSTRUCTION AND FUEL...

In 2004, 35 percent of the 934,000 acres the USDA Forest Service thinned for forest health produced byproducts later used in products such as engineered lumber, paper and pulp, furniture, composites, plastics, and biofuels such as ethanol and diesel. The use of fiber from forest treatments or from short rotation woody crops to replace petroleum-based products is on the increase. Besides reducing reliance on nonrenewable energy sources, these biobased products support rural economies by providing new markets for previously unmarketable wood. By creating new uses for trees grown on privately owned lands, biobased products also help protect forests from the fragmentation that results when these lands are converted to other uses.

Fiber Is Fiber, Right?

Depending on their source, wood fibers vary in length, width, flexibility, and chemical makeup. These traits affect how well suited a fiber is for a particular use, especially for construction materials. Southern Research Station scientists at the **southern forest resources utilization unit in Pineville, LA**, take two approaches to examining wood fiber. First, they look at the physical characteristics—length, width, and flexibility—that can affect the quality of wood composites. For a second group of studies, they analyze the chemical composition that affects the use of wood fiber as feedstock for ethanol and other biofuels.

Researchers at the unit have on hand an array of sophisticated methods and technologies to examine wood fiber. Using scanning electron and atomic force microscopes, they zoom in to the subatomic level to test how individual fibers respond to different levels of pressure. Another technique, called near infrared spectroscopy, uses different wavelengths of infrared light to determine the chemical composition and biological properties of fiber samples. "One of the biggest challenges to effectively using small diameter wood for products or energy is characterizing it as a raw material," says **Les Groom**, project leader of the wood utilization unit. "Traditional lab tests are expensive and time-consuming. At our lab, we continue to develop the methods that have already put us in the forefront in determining the mechanical properties of individual wood fibers as well as designing rapid material assessment tools."

For the Construction Industry, All Fibers Are Not Created Equal

Composite materials for the construction industry are made by gluing small pieces of wood together under pressure or heat. Examples include particleboard, flakeboard, and fiberboard. Builders value these materials because they are designed and engineered for a particular use and provide an economic advantage over solid wood. Composites are also more consistent in strength and less likely to bend or warp.Composites can be made from almost any form of wood—whole logs, small diameter wood, or lumber manufacturing waste—but can also vary greatly in quality. "How well these materials perform depends on the properties of the wood fibers, the polymer binder used to glue them together, and qualities of the interface where these come together," says Groom.

Fibers from small diameter wood thinned from forests or grown as short rotation woody crops are much more flexible than those from mature

What are biobased products?

Made from renewable sources such as wood, biobased products are designed to replace products currently made from petroleum-based sources. Usually biodegradable or recyclable, biobased products include construction materials, chemicals, pharmaceuticals, textiles, packaging materials, and liquid fuels such as ethanol.

(Photo by Warren Gretz, NREL)

hardwood. "When developing structural components for roofing, for example, you want the materials you start with to be very stiff, so you use mostly fiber from mature trees," says Groom. "For fiberboard, which is used mainly for furniture or cabinets, the stiffness is not as critical. It is not so important that the individual fiber is strong, but it should be flexible enough to touch and bond with many other fibers."

Researchers have found that some of the fiber from small diameter wood is suitable for structural materials, and some can be used for flooring, paneling, and furniture. There remains, however, a large amount of small diameter fiber that is not suitable for any of these high-value purposes. This is especially true of wood thinned to reduce fire hazard or promote forest health. This material may have knots, whorls, and other conditions that cause the fibers to twist when they dry. Although this wood can still be composted or burned, it would have higher market value if it could be used as a feedstock for biofuels such as ethanol, methanol, or biodiesel.

Fibers Into Fuel

"When we look at wood fiber as potential feedstock for fuels, we completely disregard the anatomical features," says Groom. "We look at the chemical components—carbon, hydrogen, nitrogen, and oxygen—and how we can alter what's there to produce the desired end product. At the same time, we are looking at the chemical composition of downed wood in the forest understory itself, trying to determine what makes it a fire hazard and what relation this has to its potential as a chemical feedstock."

Using thinnings or residues as chemical feedstock could provide an immediate benefit to forest managers. "In Louisiana alone, there are over 600,000 acres of national forest," says Groom. "Just to keep the fuel load on the forest floor down, the national forest tries to burn about 150,000 acres a year. This is a tremendous undertaking, costly and hard to coordinate. If this material could be harvested as feedstock for fuels, it would save the national forest the $25 to $35 an acre it costs to burn, while improving forest health and adding another source of renewable energy." Harvesting small diameter wood for this purpose could also become a viable business for local contractors.

Groom's unit is starting a new project to analyze the waste that results when wood is cooked for composites. "We will heat up chips of wood under pressure, put them between plates, and then pull them apart until all we have left is individual fibers," says Groom. "We will vary the process and look at the composition of the sugars that come out to see if they can be easily converted to ethanol. It isn't easy or cost effective to use fiber for ethanol now because of the chemical structure of wood itself."

Growing Better Fiber

Southern yellow pines—a term that includes longleaf, shortleaf, slash, and loblolly pines—are the source of most of the fiber used for building materials in the United States. Fiber comes from a variety of land ownership sources, including public, private, and industrial lands. The management practices used to grow trees on these different lands vary widely; the effect of different silviculture practices on fiber quality is virtually unknown. Groom's unit is looking at how silviculture practices and growth conditions affect the quality of fiber, and they are developing tools that can be used in the field to evaluate wood quality. "Most field studies just take a core sample to look at density at breast height," says Groom. "We are looking at how we can use the whole tree to determine timber quality. A better understanding of the relationships between site conditions and wood quality will allow managers to select the best locations and conditions to grow the quality of fiber needed for high-value uses."

For more information:
Les Groom at (318-473-7267) or lgroom@fs.fed.us

Waste Not, Want Not!

...In 1999, an estimated 233 million pallets, equal to 23.5 million small diameter hardwood trees, were repaired and sold to pallet users...

Recycling wood products offers another way to save energy and avoid wasting forest resources. Pallets, the racks used by almost every industry to move materials around, are made from hardwoods—oak, walnut, and maple—harvested from U.S. forests. Until recycling efforts started about a decade ago, most pallets ended up in landfills after one use. "An incredible amount of America's hardwood still goes into landfills every year," says **Phil Araman,** project leader for the Southern Research Station **(SRS) forest products conservation unit** in Blacksburg, VA. "We estimate that 38 percent of the hardwood produced in the United States, about 4.5 billion board feet, is used to make pallets." Nationally, pallets make up 2 percent of all municipal solid waste and 3 percent of construction and demolition landfill waste.

Over the last decade, the Blacksburg unit has worked with a wide range of cooperators, notably researchers from Virginia Tech University, to demonstrate how pallets can be repaired or made into new products. Through the electronic Pallet Design System, the unit's research on the strength properties of used pallet parts, repaired pallets, and remanufactured pallets can now be used by the over 200 companies that rebuild pallets from used materials. Unit researchers travel across the Southeast, helping people evaluate the feasibility of starting a recycling business. "The beauty of pallet recycling is that two people can start up a business with very little capital," says Araman. "There are always pallets to be hauled away or retrieved from landfills, and a good market for the repaired product. Recycling pallets has grown to a $1.2 billion industry."

Eventually the wood is too damaged to use for rebuilding. The remains are often pressed into fuel pellets or shredded into mulch or animal bedding—not the highest value use for hardwood materials. Recent SRS work with the Land-of-Sky Regional Council in Asheville, NC, and North Carolina State University takes recycling a step further. Using pallets from landfills and pallet recylcers, the cooperators helped set up a pallet-to-flooring operation with Oaks Unlimited of Waynesville, NC. Since individual pallets are made from a mix of hardwoods and are heavily nailed, the flooring varies in color and is marked by nail holes. These imperfections, which give the flooring a rustic look and show that it really is a recycled product, have actually become a drawing point for designers and homeowners. "The pallet product is comparable to any other high-end flooring and can be sold at around $5 a foot," says Araman. "This adds $1 to $2 to the price for pallets used for repair. The labor and capital costs for setting up a pallet-to-flooring business are relatively low, and production costs comparable with other high-end flooring. Our studies show this can be a profitable business, with the added attraction of reducing the number of hardwoods harvested from American forests."

For more information:
Phil Araman at (540-231-5341) or paraman@fs.fed.us

Flooring from pallets installed as a pilot project in Sprig, an indoor plant and garden accessories shop in the Grove Arcade in downtown Asheville, NC. (Photos by R. Kindlund)

American Forests Foundation

http://www.affoundation.org/

The American Forests Foundation focuses on small forest landowners. The organization's chapters enable its members to discuss technical and policy matters, keeping them apprised of pending litigation potentially affecting their status as property owners.

Forest Stewardship

http://www.foreststeward.org/

Specifically designed for small forest landowners, this site includes information on cost-sharing opportunities and managing for forest products as well as wildlife.

National Timber Tax Website

http://www.timbertax.org

Private forest landowners can learn about timber transactions, tax strategies, State laws, and estate taxes. The significant benefits of the 2004 tax law are explained in detail. Customers can download the *Forest Landowners Guide to the Federal Income Tax* (Agricultural Handbook 718).

Southern Center for Wildland-Urban Interface Research and Information

http://www.interfacesouth.org/

Critical issues include wildland fire, watershed health and management, land use planning and policy, and wildlife conservation. Visitors can join a listserv to get the latest news.

Southern Alliance for the Utilization of Biomass Resources

http://www.saubr.au.edu

Biomass utilization could provide an economic stimulus to the South's rural economies through innovative use of forest and farm resources while decreasing energy dependence on fossil fuels. The biomass-based industry will create high volume, non-cyclical markets for trees and agricultural crops, forests and farm residues, and wood manufacturing residues.

Southern Group of State Foresters

http://www.southernforests.org/

State forestry agencies are primary providers of assistance to private landowners. This Web site links to every State forestry agency in the South. Individual State links provide information ranging from available services, ways to request land management assistance or apply for burning permits, and news about insect and disease conditions. Many State Web sites include telephone numbers and email addresses, often linked directly to farm or urban foresters.

Southern Regional Extension Forestry

http://sref.info/

A consortium of State and Federal agencies and universities from across the South contribute to this site, which gets high marks for timeliness. In November 2004, for example, the Web site included information on how to request Federal help managing lands damaged by the hurricanes that struck central Florida and the Gulf Coast.

Urban Forests Ecosystem Institute

http://www.ufei.calpoly.edu/

The UFEI site includes a broad range of topics, from coping with the latest introduced pests to managing reclaimed lots for urban forest wildlife. It also includes a huge library of downloadable, copyright-free photos. The UFEI site provides free access to an online discussion group now exceeding 540 members.

USDA Forest Service Cooperative Forestry

http://www.fs.fed.us/spf/coop/

This site features a diverse array of links, including downloadable publications, news, an online library, the latest information on regulations, and Federal financial incentive programs available to landowners.

USDA Forest Service, Southern Research Station

http://www.srs.fs.usda.gov/

Small landowners can benefit from many Southern Research Station products and publications. Stakeholders can access and download nearly 9,000 full-text publications online, and link to individual research units focused on specific areas of study.

Landowner's TOOLBOX

WHAT CAN EXPERIMENTAL FORESTS TEACH US ABOUT BIOMASS?

Since the 1920s, the USDA Forest Service has maintained a system of experimental forests to test hypotheses and collect long-term data about the ecological effects of fire, grazing, insect infestations, air pollution, and other disturbances. In the South, researchers from Federal agencies and universities use 15 active experimental forests for studies ranging from the practices needed to maintain healthy forests, to the water filtration functions of forests, to habitat restoration for endangered species.

The **Crossett Experimental Forest** in southwestern Arkansas got its start in 1934 when the Crossett Lumber Company (now Georgia-Pacific Corporation) donated a 1680-acre tract of land to the Forest Service. Unlike other logging operators of the time, which were notorious for the "cut out and get out" practice of abandoning logging sites, Crossett had a history of working with Federal researchers to restore cut-over Arkansas land into commercially valuable stands of loblolly and shortleaf pine.

Over the years, research on the Crossett has provided the tools that landowners need to sustain their forests for a variety of benefits, including timber and aesthetics. Nearly 50,000 foresters, landowners, students, and teachers have visited Crossett's research plots, where, for example, they have learned about single-tree harvesting on the Good Forty Demonstration Area, controlling woody and herbaceous competition in loblolly and shortleaf stands, and comparing the costs and advantages of intensively managed plantations to natural stands. When Hurricane Hugo struck the Carolina coastal forests in 1989, findings from an earlier hurricane on the Crossett provided valuable baseline information on salvage costs and marketing opportunities for downed timber.

As forest industry continues to divest itself of timberland, and parcel sizes held by nonindustrial owners become smaller and less likely to be focused on production of pulpwood for paper manufacturing, the lessons learned by researchers at the Crossett will become more valuable. In the gulf and mid-South States (Louisiana, Mississippi, and Louisiana)—and in areas further eastward (southwestern Georgia and the eastern Virginia-Carolina border)—idle farmland is rapidly being planted in pine with little forethought given to intended uses. The owners of these new plantations may be financially unable or philosophically unwilling to carry out the intensive practices that will protect their holdings from wildfires, infestations, and diseases.

The key to growing healthy, well-stocked forests is to eliminate trees that are ill-formed and damaged and vegetation that can out-compete desired species for sunlight, nutrients, and other basic needs. The challenge has always been to find economically and environmentally acceptable processes for removing, transporting, and using the "cull," which is often small diameter wood for which there are no ready markets. As new biomass technologies and markets emerge across the South, landowners can become better and smarter stewards of their land if they have sufficient data and guidance. Deep in the Coastal Plain forests of Arkansas, the Crossett Experimental Forest stands ready to deliver.

Where to start?

Drop in at the Crossett Experimental Web site at www.srs.fs.usda.gov/4106/Crossett/crossett_ef.htm to get a list of resource materials and a schedule for Crossett's 19th annual Forestry Field Day.

(USDA Forest Service photo)

around the STATION...

Experimental Forests

1. Bent Creek NC
2. Blue Valley NC
3. Coweeta NC
4. John C. Calhoun SC
5. Santee SC
6. Scull Shoals GA
7. Hitchiti GA
8. Olustee FL
9. Chipola FL
10. Escambia AL
11. Tallahatchee MS
12. Delta MS
13. Harrison MS
14. Palustris LA
15. Stephen F. Austin TX
16. Crossett AR
17. Alum Creek AR
18. Sylamore AR
19. Henry F. Koen AR

AGROFORESTRY CENTER MOVES TO THE SOUTH

The **National Agroforestry Center** has been realigned within the USDA Forest Service to transfer both its research and its science delivery functions from the Rocky Mountain Research Station to the Southern Research Station (SRS). Effective December 26, center director **Greg Ruark** relocated to the campus of Alabama A&M University, where he will serve as SRS program manager for Agroforestry, reporting to Station director Pete Roussopoulos. The move will build on agroforestry momentum that has begun in the South and will expand the Center's collaboration with Alabama A&M and other historically Black universities through the 1890 Agroforestry Consortium.

For the time being, the agroforestry research unit will remain in Lincoln, NE under the leadership of **Michele Schoeneberger**. The unit consists of three research scientists, an agroforester, two technology transfer specialists, and several professional and support staff.

The National Agroforestry Center had its origins in the 1990 Farm Bill. It began as a Forest Service effort in 1992 and expanded into a partnership with the Natural Resources Conservation Service in 1995. The Center conducts research on how to design and install forested buffers to protect water quality and develops and delivers technology on a broad suite of agroforestry practices to natural resource professionals who directly assist landowners and communities.

Agroforestry is the intentional blending of agricultural and forestry production and conservation practices. Agroforestry technologies can be readily incorporated into most agricultural operations and are also useful to many communities. These practices provide cost effective ways to diversify production and increase income, while simultaneously enhancing natural resource conservation.

The Center's **current research** focus is on tree-based buffer technologies for sustainable land use, with studies conducted to:

- Improve the understanding of how forested riparian and upland forest buffers function to protect water and aquatic environments from soil sediments, excess nutrients, and pesticides

- Enhance the design and installation of buffer systems under a variety of environmental conditions to meet landowner objectives

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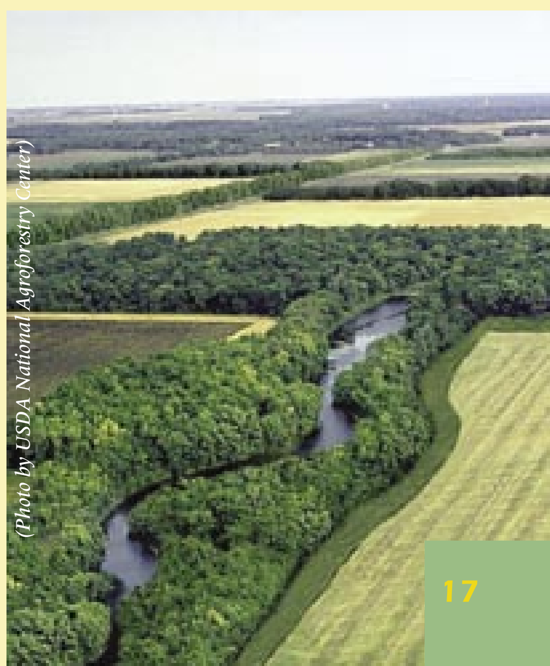

(Photo by USDA National Agroforestry Center)

(continued from page 17)

- Guide the strategic placement of forested buffer systems in watersheds to maximize water protection, while optimizing other benefits, such as wildlife habitat, carbon sequestration, and economic diversification

The Center's current technology transfer and applications program serves as a contact point, clearinghouse, and catalyst to accelerate the development, application, and acceptance of agroforestry technologies for farms, ranches and communities. The Center gathers and packages research conducted by universities and by State and Federal agencies into technology transfer materials. These materials include field demonstrations, training workshops, a quarterly newsletter, technical "how to" notes, videos, and brochures with coordinating displays.

New Grants for Biomass Research and Outreach

The South produces 60 percent of the Nation's timber supply, leaving low quality small diameter trees and a high volume of wood waste to accumulate as fuel for wildfires. Recognizing the lack of commercial markets for this material, the U.S. Departments of Energy and Agriculture have established competitive grants to develop products and energy sources that can create revenue streams for rural communities. The Southern Research Station has successfully competed for two $1 million grants in collaboration with universities, forest products companies, State agencies, and other Federal agencies.

The first grant was awarded to a collaborative that also includes the University of Florida, Cooperative Extension Service, and the Southern States Energy Board Biobased Alliance. It will establish a "Wood to Energy" training program to increase the likelihood that woody biomass will be used to generate power by linking potential fuel users to rural and urban communities with nearby biomass supplies. The program will gather information and experience from various fields—economics, psychology, forestry, engineering, and education—to generate products that include an economic analysis of 14 communities in the South and Puerto Rico, case studies of existing bioenergy production facilities, a curriculum manual and program materials, train-the-trainer and community workshops, and a community support Web site with satellite forums.

The second grant was awarded to the **Southern Forest Research Partnership**, which has membership from all parts of the forest research and education community in the South. This grant is more focused on individual land manager and owners, applying the vast results of decades-long research rather than waiting for new knowledge to be developed. Key elements of the effort are the synthesis of research results into an online hypertext encyclopedia, the creation of information products and technologies based on a user needs assessment, and the development of curricula, training events, and Internet/satellite programs to ensure adoption of new knowledge and technologies.

In addition to supporting the Partnership's science delivery efforts, the Southern Station provides survey data that will be needed to develop a baseline for regional studies on biomass use. Among these studies are several already underway at the Station. In Louisiana, research foresters are developing methods to grow biomass crops and research technologists have begun work to identify the qualities of forest–derived biomass that contribute to bioenergy and product utility. Station researchers in the forest operations unit at Auburn University continue to design methods and equipment needed for sustainable harvesting of small diameter wood. And plans are underway to conduct site-specific biomass production studies that include analyses of economic and environmental impacts and rural development potential.

New Forester at Bent Creek

Susan Matthews joined the staff at the **Bent Creek Experimental Forest** in July 2004, moving into the Technology Transfer and Public Outreach position previously held by Erik Berg. Matthews is also coordinating the management of the Bent Creek and Blue Valley Experimental Forests. "This is the first time I have worked on the research side of Forest Service," she says. "I am looking forward to building on the strong technology transfer program here at Bent Creek by reaching out to new audiences."

Before coming to Asheville, Matthews worked for 26 years in the Western United States for the National Forest Systems side of the Forest Service, most recently as the district ranger on the Almanor Ranger District of the Lassen National Forest in northeastern California. Prior to her assignment in California, she spent over 10 years on the Idaho Panhandle National Forests (IPNF) as district ranger of the 732,000-acre Coeur d'Alene River Ranger District in the heart of northern Idaho's elk country. Prior to the Coeur d'Alene district ranger assignment, Matthews was the forest silviculturist on the IPNF responsible for the vegetation management programs that included the reforestation, timber stand improvement, and tree improvement programs. Other assignments have taken her to the Nez Perce and Kootenai National Forests in the Northern Region and the Pacific Southwest Regional Office Timber Staff.

Matthews has a Bachelor of Science degree in natural resources management from Colorado State University. She received a Master of Science degree in forest management from the University of Idaho. Originally from Levittown, New York, this is the first time she has lived on the East Coast since graduating from high school.

(Photo by R. Kindlund)

(Photo by B. Lea)

NEW PRODUCTS

Southern Pine Ecosystems

1 Brockway, Dale G.; Outcalt, Kenneth W.; Tomczak, Donald J.; Johnson, Everett E. 2005. Restoring longleaf pine forest ecosystems in the Southern United States. In: Stanturf, John A.; Madsen, Palle, eds. Restoration of boreal and temperate forests. Boca Raton, FL: CRC Press: 501-519.

Longleaf pine (*Pinus palustris*) ecosystems are native to nine states of the southern region of the United States. Longleaf pine can grow on a variety of site types including wet flatwoods and savannahs along the Atlantic and Gulf Coastal Plain, higher droughty sand deposits from the fall line sandhills to the central ridge of Florida, and the montane slopes and ridges of Alabama and northwest Georgia up to 600 m. This region has a humid subtropical climate. Maximum July temperatures average 29°C to > 35°C while minima during January range from 0 to 13°C. The mean annual precipitation is 1,040 to 1,750 mm and is well distributed through the year. The growing season is comparatively long, ranging from 300+ days in Florida to 220 days along the northern limit of longleaf. During the late summer and fall, hurricanes can develop over the Atlantic Ocean, move westward, and impact coastal plain forests. Such tropical storms are one of the principal large-scale disturbance agents for longleaf pine forests growing near the seacoast.

2 Clark, Alexander, III. 2004. Impact of vegetation control and annual fertilization on properties of loblolly pine wood at age 12. Forest Products Journal. 54 (12): 90-96.

Loblolly pine (*Pinus taeda* L.) stands in the Coastal Plain and Piedmont of Georgia were subjected to four intensive silvicultural regimes to monitor and record relative tree growth. Treatments included intensive mechanical site preparation; complete vegetation control with multiple applications of herbicides; annual high rates of nitrogen fertilization; and complete vegetation control plus annual high rates of nitrogen fertilization. In response to the intense cultural practices, growth increased 270 percent in the Coastal Plain and 58 percent in the Piedmont compared to the intensive mechanical site preparation treatment. Increment cores were collected from trees at age 12 to determine the impact of intensive cultural practices on earlywood and latewood specific gravity and duration of juvenility. Trees were also felled to determine the impact of intensive cultural practices on wood stiffness, strength, and toughness.

3 Cohen, Susan; Braham, Richard; Sanchez, Felipe. 2004. Seed bank viability in disturbed longleaf pine sites. Restoration Ecology. 12 (4): 503-515.

Some of the most species-rich areas and highest concentrations of threatened and endangered species in the Southeastern United States are found in wet savannah and flatwood longleaf pine (*Pinus palustris* Mill.) communities. Where intensive forestry practices have eliminated much of the natural understory of the longleaf ecosystem, the potential for reestablishment through a seed bank may present a valuable restoration opportunity. Longleaf pine sites converted to loblolly pine plantations and non-disturbed longleaf sites on the Coastal Plain of North Carolina were examined for seed bank presence and diversity. Conducting vegetation surveys and examining the seed bank using the seedling emergence technique allowed for verification of the seed bank presence, as well as evaluation of the quality of the seed bank on disturbed longleaf pine sites. Forty-three species and over 1,000 individuals germinated, and the seed banks of both the disturbed and non-disturbed stand types contained species not noted in the vegetation survey. Although many of these species were considered weedy and typical of disturbance, numerous taxa were indicative of stable longleaf pine communities. This study confirms both the presence and quality of seed banks in highly disturbed former longleaf pine sites, suggesting that the seed bank may be an important tool in restoration efforts.

4 Fischer, Joseph B.; Miller, James H. 2004. Ion chromatography as an alternate to standard methods for analysis of macronutrients in Mehlich 1 extracts of unfertilized forest soils. Communications in Soil Science and Plant Analysis. 35 (15-16): 2191-2208.

This study evaluates ion chromatography (IC) as an alternative to atomic absorption (AA) and inductively coupled plasma spectrometry (ICP) for analysis of potassium (K), magnesium (Mg), and calcium (Ca), and as an alternative to antimonylmolybdate colorimetry and ICP for analysis of phosphorus (P) macronutrients in Mehlich 1 extracts. Soils typical of pine forests in the Southeastern United States were tested. IC correlates well with AA and ICP for K and Ca, but not for Mg, unless conditions are chosen that resolve Mg from manganese (Mn). IC does not correlate very well with colorimetry for P at extract levels below 2 mg kg^{-1} or in extracts with high levels of dissolved organic matter complexes of aluminum (Al) and iron (Fe). ICP results for P exceed both IC and colorimetry by 3-5 mg kg^{-1} for all soils tested. The merits of IC relative to AA, ICP, and colorimetry for forest soil testing are discussed.

5 Rudolph, D. Craig; Ely, Charles, A. 2000. The influence of fire on Lepidopteran abundance and community structure in forested habitats of eastern Texas. Texas Journal of Science. 52 (4) supplement: 127-138.

Transect surveys were used to examine the influence of fire on lepidopteran communities (*Papilionoidea* and *Hesperioidea*) in forested habitats in eastern Texas. Lepidopteran abundance was greater in pine forests where prescribed fire maintained an open mid- and understory compared to forests where fire had less impact on forest structure. Abundance of nectar sources paralleled this pattern of abundance. Taxonomic groups of Lepidoptera varied across forest types in patterns coincident with their dependence on nectar sources and tendency to fly in shaded habitats.

Wetlands, Bottomlands, and Streams

6 Adams, Susan B.; Warren, Melvin L., Jr.; Haag, Wendell R. 2004. Spatial and temporal patterns in fish assemblages of Upper Coastal Plain streams, Mississippi, USA. Hydrobiologia. 528: 45-61.

We assessed spatial, seasonal, and annual variation in fish assemblages over 17 months in three small- to medium-sized, incised streams characteristic of northwestern Mississippi streams. We sampled 17,962 fish representing 52 species and compared assemblages within and among streams. Although annual and seasonal variability in assemblage structure was high, fish assemblages maintained characteristics unique to each stream. High variability in fish catch-per-unit-effort (CPUE) was exemplified in one site where total CPUE increased an order of magnitude from July 1993 to 1994. Species turnover and percent dissimilarity were often higher seasonally than annually, consistent with a period of change in spring to early summer and a return to similar species compositions between summers. Temporal variability was also high at the individual species level, and no species were classified as "stable." Flashy hydrographs, created in part by stream channelization and incisions and watershed deforestation, may play a large role in structuring these fish assemblages. Extreme interannual variability in assemblages in the absence of detectable habitat change has important implications for the statistical power of fish monitoring programs designed to detect trends in fish assemblages over time.

7 Coleman, Mark D.; Friend, Alexander, L.; Kern, Christel C. 2004. Carbon allocation and nitrogen acquisition in a developing *Populus deltoides* plantation. Tree Physiology. 24: 1347-1357.

We established *Populus deltoides* Bartr. stands differing in nitrogen (N) availability and tested if:

- N-induced carbon (C) allocation could be explained by developmental allocation controls;
- N uptake per unit root mass, i.e., specific N-uptake rate, increased with N availability.

Closely spaced (1 × 1 m) stands were treated with 50, 100, and 200 kg N ha^{-1} year 1^{-1} of time-release balanced fertilizer (50N, 100N, and 200N) and compared with unfertilized controls (0N). Measurements were made during two complete growing seasons from May 1998 through October 1999. Repeated nondestructive measurements were carried out to determine stem height and diameter, leaf area, and fine-root dynamics. In October of both years, above- and belowground biomass was harvested, including soil cores for fine-root biomass. Leaves were harvested in July 1999. Harvested tissues were analyzed for C and N content. Nondestructive stem diameter and fine-root dynamic measurements were combined with destructive harvest data to estimate whole-tree biomass and N content at the end of the year, and to estimate specific N-uptake rates during the 1999 growing season. Shoot growth response was greater in fertilized trees than in control trees; however, the 100N and 200N treatments did not enhance growth more than the 50N treatment. Root biomass proportions decreased over time and with increasing fertilizer treatment. Fertilizer-induced changes in allocation were explained by accelerated development. Specific N-uptake rates increased during the growing season and were higher for fertilized trees than for control trees.

8 Gardiner, Emile S.; Stanturf, John A.; Schweitzer, Callie J. 2004. An afforestation system for restoring bottomland hardwood forests: biomass accumulation of Nuttall oak seedlings interplanted beneath eastern cottonwood. Restoration Ecology. 12 (4): 525-532.

Bottomland hardwood forests of the Southeastern United States have declined in extent since European settlement. Forest restoration activities over the past decade, however, have driven recent changes in land use through an intensified afforestation effort on former agricultural land. This intense afforestation effort, particularly in the Lower Mississippi Alluvial Valley, has generated a demand for alternative afforestation systems that accommodate various landowner objectives through restoration of sustainable forests. We are currently studying an afforestation system that involves initial establishment of the rapidly growing native species eastern cottonwood (*Populus deltoides* Bartr. ex Marsh.), followed by enrichment of the plantation understory with Nuttall oak (*Quercus nuttallii* Palm.). In this article, we examine the growth and biomass accumulation by Nuttall oak seedlings to determine whether this species can be established and whether it will develop beneath the cottonwood overstory. Though establishment in the more shaded understory environment reduced Nuttall oak growth, seedling function was not limited enough to induce changes in plant morphology. Our results suggest that an afforestation system involving rapid establishment of forest cover with a quick-growing plantation species, followed by understory enrichment with species of later succession, may provide an alternative method of forest restoration on bottomland hardwood sites and perhaps other sites degraded by agriculture throughout temperate regions.

9 Schmetterling, David A.; Adams, Susan B. 2004. Summer movements within the fish community of a small montane stream. North American Journal of Fisheries Management. 24: 1163-1172.

We studied movements by fishes in Chamberlain Creek, MT, from 24 July to 16 August 2001. We operated six weirs with two-way traps and one additional upstream trap, separated by 14-1,596 m, to quantify the timing, direction, and distance of movements and to estimate fish populations in the study reaches. We trapped and marked 567 fish of seven species, including 368 westslope cutthroat trout *Oncorhynchus clarkii lewisi* and 172 sculpin (slimy sculpin *Cottus cognatus* and an unidentified species similar to mottled sculpin *C. bairdii*). We recaptured 173 westslope cutthroat trout and detected net movements as long as 1,581 m (median, 91 m). Bidirectional movements for 116 westslope cutthroat trout ranged from less than 18 to more than 1,581 m (median, 64 m). Sculpin moved as far as 209 m (median, 26 m). We estimate that 14 percent of sculpin and 48 percent of westslope cutthroat trout were mobile during the study. We captured all species more frequently at night or twilight (n = 296) than during the day (n = 83) and more frequently moving downstream (n = 419) than upstream (n = 277). These results demonstrate considerable summer movement by the fish community in a small stream.

Mountain and Highland Ecosystems

10 Elliott, Katherine J.; Vose, James M.; Clinton, Barton D.; Knoepp, Jennifer D. 2004. Effects of understory burning in a mesic mixed-oak forest of the Southern Appalachians. In: Engstrom, R.T.; Galley, K.E.M.; de Groot, W.J. (eds.). Proceedings of the 22nd Tall Timbers fire ecology conference: fire in temperate, boreal, and montane ecosystems. Tallahassee, FL: Tall Timbers Research Station; 272-283.

Information is lacking on ecosystem effects of understory burning in mesic mixed-oak (*Quercus spp.*) forests of the Southern Appalachians. Native Americans used periodic fires in these forests for driving game and opening the forest. In April 1998, we conducted a low- to moderate-intensity fire in a cove hardwood forest in the Nantahala National Forest, western North Carolina. In March 1998, before burning, permanent plots were established along three parallel transects to measure forest floor mass, carbon, and nitrogen; soil nutrient availability; and vegetation mortality and regeneration. Forest floor material was sampled by components: small wood, litter, and a combined fermentation and humus component. Soil nutrient availability was estimated using cation and anion exchange membrane sheets. Vegetation measurements included the overstory and understory layers. All parameters were resampled during summer 1998 and 1999 in the same manner

(USDA Forest Service photo)

as the pre-burn inventories. Moderate-intensity understory burning may be a useful tool to restore mesic mixed-oak communities in the Southern Appalachians. Reintroduction of fire into these ecosystems may be beneficial by increasing soil nutrient availability, promoting regeneration and survival of *Quercus spp.*, increasing diversity of understory species, and reducing abundance of shade-tolerant and fire-intolerant species such as *Acer rubrum*.

11 Vose, James M.; Geron, Chris; Walker, John; Raulund-Rasmussen, Karsten. 2005. Restoration effects on N cycling pools and processes. In: Stanturf, John A.; Madsen, Palle, eds. Restoration of boreal and temperate forests. Boca Raton, FL: CRC Press: 77-94.

We presented two different aspects of evaluating effects of restoration on biogeochemical cycling and aquatic ecosystems. The first examined the direct responses of nutrient cycling pools and processes to restoration efforts aimed at improving nitrogen retention and processing degraded riparian zones. The second, stream NO_3^- responses of restoration burning, examined responses to restoration efforts that do not target biogeochemical cycling per se, but directly or indirectly influence nutrient cycling pools and processes. We presented an approach to evaluate short- and long-term responses of restoration on biogeochemical cycling using the resistance and resilience analogy. Our adaptation of the resistance/resilience analogy to evaluate restoration responses focused on three key attributes:

- The complexity of ecosystem biogeochemical cycling requires the determination of key indicators of response.
- Evaluation of responses (direct or nontarget) can be approached by assessing response magnitude and duration.
- Variable responses should be expected since the impacts of degradation may impact pools and processes differently.

Inventory and Monitoring

12 Bechtold, William A. 2004. Largest-crown-width prediction models for 53 species in the Western United States. Western Journal of Applied Forestry. 19 (4): 245-251.

The mean crown diameters of stand-grown trees 5.0 inch d.b.h. and larger were modeled as a function of stem diameter, live-crown ratio, stand-level basal area, latitude, longitude, elevation, and Hopkins bioclimatic index for 53 tree species in the Western United States. Stem diameter was statistically significant in all models, and a quadratic term for stem diameter was required for some species. Crown ratio and/or Hopkins index also improved the models for most species. A term for stand-level basal area was not generally needed but did yield some minor improvement for a few species. Coefficients of variation from the regression solutions ranged from 17 to 33 percent and model R^2 ranged from 0.15 to 0.85. Simpler models, based solely on stem diameter, are also presented.

Large-Scale Assessment and Modeling

13 Butnor, J.R.; Johnsen, K.H. 2004. Calibrating soil respiration measures with a dynamic flux apparatus using artificial soil media of varying porosity. European Journal of Soil Science. 55: 639-647.

Measurement of soil respiration to quantify ecosystem carbon cycling requires absolute, not relative, estimates of soil CO^2 efflux. We describe a novel, automated efflux apparatus that can be used to test the accuracy of chamber-based soil respiration measurements by generating known CO^2 fluxes. Artificial soil is supported above an air-filled footspace wherein the CO^2 concentration is manipulated by mass flow controllers. The footspace is not pressurized so that the diffusion gradient between it and the air at the soil surface drives CO^2 efflux. Chamber designs or measurement techniques can be affected by soil air volume, hence properties of the soil medium are critical. On the least porous soil, small underestimates (< 5 percent) of CO^2 effluxes were observed, which increased as soil diffusivity and soil porosity increased, leading to underestimates as high as 25 percent. Differential measurement bias across media types illustrates the need for testing systems on several types of soil media.

14 Holmes, Thomas P.; Prestemon, John M.; Pye, John M. [and others]. 2004. Using size-frequency distributions to analyze fire regimes in Florida. In: Engstrom, R.T.; Galley, K.E.M.; de Groot, W.J. (eds.). Proceedings of the 22nd Tall Timbers fire ecology conference: fire in temperate, boreal, and montane ecosystems. Tallahassee, FL: Tall Timbers Research Station; 88-94.

Wildfire regimes in natural forest ecosystems have been characterized with power-law distributions. In this paper, we evaluated whether wildfire regimes in a human-dominated landscape were also consistent with power-law distributions. Our case study focused on wildfires in Florida, a State with rapid population growth and consequent rapid alteration of forest ecosystems and natural fire regimes. We found that all fire size-frequency distributions evaluated in this study were consistent with power-law distributions, but the power-law distributions were piece-wise linear. A kink in the power-law distributions occurred at about 640 ha for flatwoods fires and at about 290 ha for swamp fires. Above these levels, fires "exploded" into a catastrophic regime. If the kink represents the level at which fires become

(Photo by B. Lea)

immune to fire suppression effort, we would expect that the location of the kink would occur at smaller fire sizes during extreme fire years due to the increased flammability of fuels and the relative scarcity of fire suppression resources. We found this result for three of four extreme fire years in flatwoods ecosystems and for all four extreme fire years in swamps. These results suggest that catastrophic fires may not be possible to prevent and that suppression efforts during extreme fire years may be best applied to strategic areas that decrease the connectivity of fuels.

Foundation Programs

15 Cowling, Ellis B.; Kelman, Arthur; Powers, Harry R., Jr. 1999. George Henry Hepting: pioneer in forest pathology. Annual Review of Phytopathology. 37-19-28.

Hepting made significant and complex contributions to forest science on a diverse range of complex problems. He had the ability to identify primary causal factors and rapidly gain the depth of understanding of disease situations that enabled him to devise practical approaches for management practices. Long before the concepts of integrated pest management became fashionable, Hepting emphasized the need to integrate disease hazard evaluations and knowledge of disease development processes into economically and biologically sound forest management systems. He also championed the need for basic research as a foundation for practical understanding and management of disease in forests. His role in the timber resources review of 1953 also permanently changed our perception of the nature and magnitude of disease losses in forests.

16 Greene, John L.; Straka, Thomas J.; Dee, Robert J. 2004. Nonindustrial private forest owner use of Federal income tax provisions. Forest Products Journal. 54 (12): 59-66.

Seven provisions of the Federal income tax provide incentives for nonindustrial private forest (NIPF) owners to follow sound management and reforestation practices. Four provisions are available to taxpayers in general:

- Long-term capital gain treatment of qualifying income
- Annual deduction of management costs
- Depreciation and the section 179 deduction
- Deductions for casualty losses or other involuntary conversions

Three provisions are specifically for forest owners:

- Reforestation tax credit
- Amortization of reforestation expenses
- Ability to exclude qualifying reforestation cost-share payments from gross income

NIPF owners in South Carolina were surveyed by mail to determine whether they were aware of these tax provisions, whether they had made use of them, and their reasons for using or not using each one. Information also was collected on the owners' demographic characteristics, to test for differences between users and non-users of the provisions. Owner awareness and use was highest for long-term capital gain treatment of income and annual deduction of management costs. Some 78 percent of owners were aware of the two provisions, and 85 percent of owners who were aware of the provisions used them. Owner awareness was lowest for the ability to exclude qualifying reforestation cost-share payments, at 42 percent; owner use was lowest for loss deductions, at 23 percent. Membership in a forest owner organization, having a written forest management plan, and a high level of household income were associated with owner knowledge of beneficial tax provisions. No demographic characteristics were associated


(Photo by B. Lea)

across-the-board with owner use of provisions.

17 Mitchell, Dana; Ayala, Renee, comps. 2004. Biomass publications of the Forest Operations Research Unit: a synthesis. [CD-ROM]. Auburn, AL. [Date accessed: December 23, 2004].

The Forest Operations Unit of the Southern Research Station has been studying biomass-related topics since 1977. This CD aids the reader by organizing these publications in one easy-to-use CD, comprised of an executive summary, two bibliographies, individual publications (in PDF format), and a keyword listing. The types of publications included on this CD are presentation reports, published reports, portions of books, and Web postings.

18 Rauscher, H. Michael; Johnsen, Kurt, eds. 2004. Southern forest science: past, present, and future. Gen. Tech. Rep. SRS-75. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 394 p.

Forest scientists, managers, owners, and users have in common the desire to improve the condition of southern forests and the ecosystems they support. A first step is to understand the contributions science has made and continues to make to the care and management of forests. This book represents a celebration of past accomplishments, summarizes the current state of knowledge, and creates a vision for the future of southern forestry research and management.

19 Smith, Robert L.; Pohle, Wibke; Araman, Philip; Cumbo, Dan. 2004. Characterizing the adoption of low-grade hardwood lumber by the secondary wood processing industry. Forest Products Journal. 54 (12): 15-23.

This study investigated the adoption of low-grade lumber in the secondary hardwood industry. Factors influencing decisions regarding the utilization of low-grade lumber were identified and value-added opportunities to increase the use of low-grade lumber among manufacturers currently using higher grades were evaluated. Data were collected via a nationwide mail survey of secondary hardwood manufacturers. The single most important barrier to the adoption of low-grade lumber among secondary hardwood manufacturers is "low yield." Larger manufacturers and trade association members were found to utilize the lower grades at higher percentages when compared to smaller manufacturers and non-members. Value-added activities designed to enhance the usability of low-grade lumber should focus on decreasing processing variability in secondary operations.

20 U.S. Department of Agriculture, Forest Service. 2004. Forest residues bundling project. [CD-ROM]. 0451-2C02-MTDC. Missoula, MT: Montana Technology and Development Center, Forest Service.

The Forest Residues Bundling Project CD includes information from Bob Rummer's evaluation of the slash bundler. The CD also contains a full copy of the New Technology for Residue Removal Report in both HTML and Acrobat formats, and includes a 15-minute video of the study. This product also includes a gallery of images suitable for use in PowerPoint presentations or for Web sites.

Research Work Units

Location & Project Leader	Unit	Name & Web Site	Phone
Asheville, NC David Loftis	4101	Ecology and Management of Southern Appalachian Hardwood Forests www.srs.fs.usda.gov/bentcreek	828-667-5261
Athens, GA John Stanturf	4104	Disturbance and the Management of Southern Pine Ecosystems www.srs.fs.usda.gov/disturbance	706-559-4315
Athens, GA Jim Hanula	4505	Insects and Diseases of Southern Forests www.srs.fs.usda.gov/4505	706-559-4285
Athens, GA Ken Cordell	4901	Assessing Trends, Values, and Rural Community Benefits from Outdoor Recreation and Wilderness in Forest Ecosystems www.srs.fs.usda.gov/trends	706-559-4264
Auburn, AL Kris Connor	4105	Vegetation Management Research and Longleaf Pine Research for Southern Forest Ecosystems www.srs.fs.usda.gov/4105	334-826-8700
Auburn, AL Robert Rummer	4703	Biological/Engineering Systems and Technologies for Ecological Management of Forest Resources www.srs.fs.usda.gov/forestops	334-826-8700
Blacksburg, VA Andrew Dolloff	4202	Coldwater Streams and Trout Habitat in the Southern Appalachians www.trout.forprod.vt.edu	540-231-4016
Blacksburg, VA Philip Araman	4702	Integrated Life Cycle of Wood: Tree Quality, Processing, and Recycling www.srs4702.forprod.vt.edu	540-231-4016
Charleston, SC Carl Trettin	4103	Center for Forested Wetlands Research www.srs.fs.usda.gov/charleston	843-727-4271
Clemson, SC Susan Loeb	4201	Endangered, Threatened, and Sensitive Wildlife and Plant Species in Southern Forests www.srs.fs.usda.gov/4201	864-656-3284
Franklin, NC James Vose	4351	Evaluation of Watershed Ecosystem Responses to Natural, Management, and Other Human Disturbances	828-524-2128
Gainesville, FL Ed Macie	4951	Southern Center for Wildland-Urban Interface Research and Information www.interface.org	352-376-3213
Knoxville, TN Bill Burkman	4801	Forest Inventory and Analysis www.srsfia.usfs.msstate.edu	865-862-2027

(Photo by Texas Forest Service)


(Photo by B. Lea)

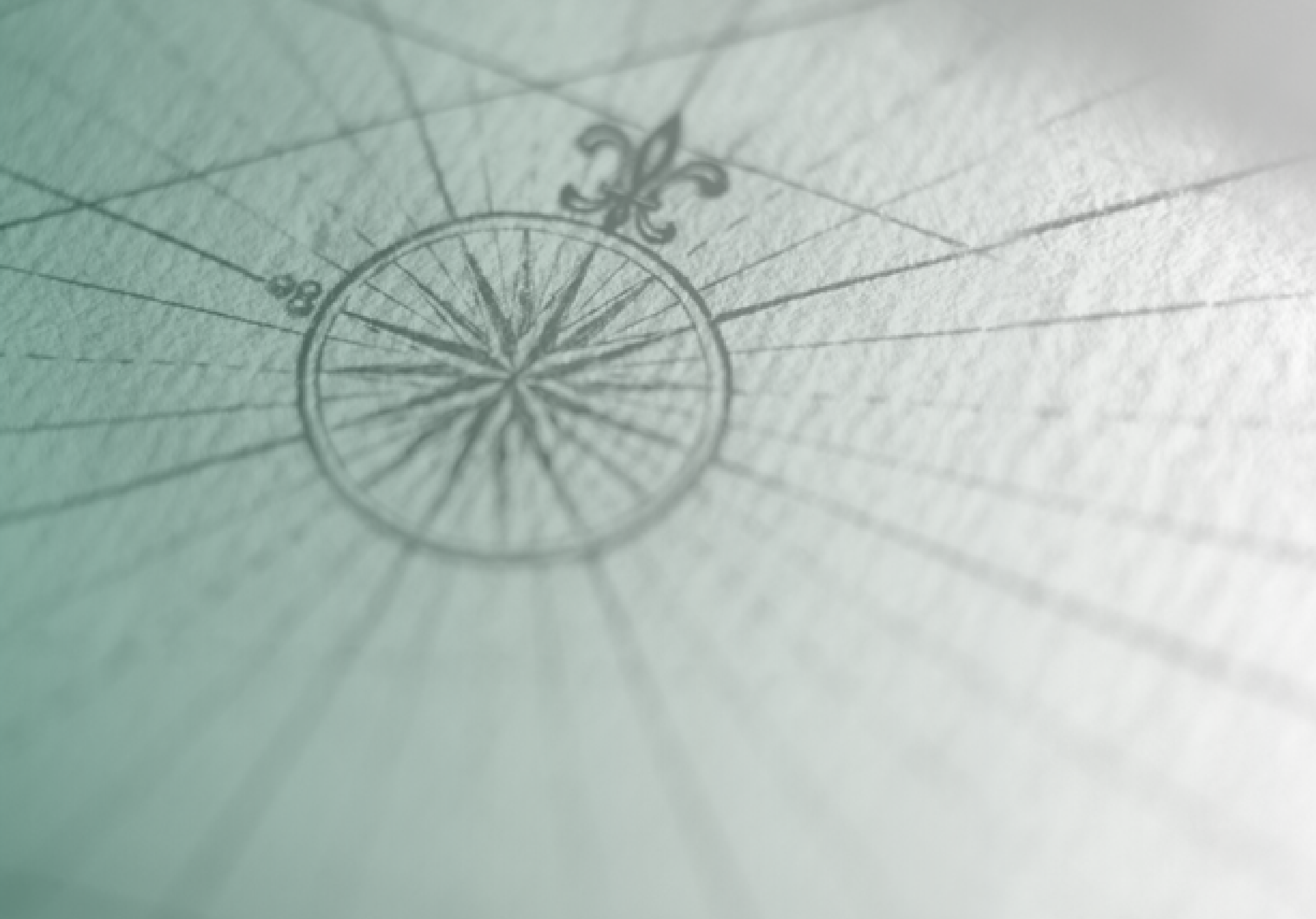
Research Work Units (Continued)

Location & Project Leader	Unit	Name & Web Site	Phone
Monticello, AR James Guldin	4106	Managing Upland Forest Ecosystems in the Midsouth www.srs.fs.usda.gov/4106	870-367-3464
Nacogdoches, TX Ronald Thill	4251	Integrated Management of Wildlife Habitat and Timber Resources www.srs.fs.usda.gov/wildlife	936-569-7981
New Orleans, LA James Granskog	4802	Evaluation of Legal, Tax, and Economic Influences on Forest Resource Management www.srs.fs.usda.gov/4802	504-589-6652
Pineville, LA James Barnett	4111	Ecology and Management of Even-Aged Southern Pine Forests www.srs.fs.usda.gov/4111	318-473-7215
Pineville, LA Kier Klepzig	4501	Ecology, Biology, and Management of Bark Beetles and Invasive Forest Insects of Southern Conifers www.srs.fs.usda.gov/4501	318-473-7232
Pineville, LA Les Groom	4701	Utilization of Southern Forest Resources www.srs.fs.usda.gov/4701	318-473-7268
Raleigh, NC Steven McNulty	4852	Southern Global Change Program www.sgcp.ncsu.edu	919-513-2974
Research Triangle Park, NC Kurt Johnsen	4154	Biological Foundations of Southern Forest Productivity and Sustainability www.rtp.srs.fs.usda.gov/soils/soilhome.htm	919-549-4092
Research Triangle Park, NC Greg Reams	4803	Forest Health Monitoring http://willow.ncfes.umn.edu/fhm/fhm_hp.htm	919-549-4014
Research Triangle Park, NC David Wear	4851	Economics of Forest Protection and Management www.rtp.srs.fs.usda.gov/econ	919-549-4093
Saucier, MS Dana Nelson	4153	Southern Institute of Forest Genetics	228-832-2747
Starkville, MS Terry Wagner	4502	Wood Products Insect Research www.srs.fs.usda.gov/termites	662-338-3100
Stoneville, MS Ted Leininger	4155	Center for Bottomland Hardwoods Research www.srs.fs.usda.gov/cbhr	662-686-3154

The mission of the Southern Research Station is to create the science and technology needed to sustain and enhance southern forest ecosystems and the benefits they provide.

“Linking science and human purpose, adaptive management serves as a compass for us to use in searching for a sustainable future.”

—Kai N. Lee, The Compass and Gyroscope—Integrating Science and Politics for the Environment. *



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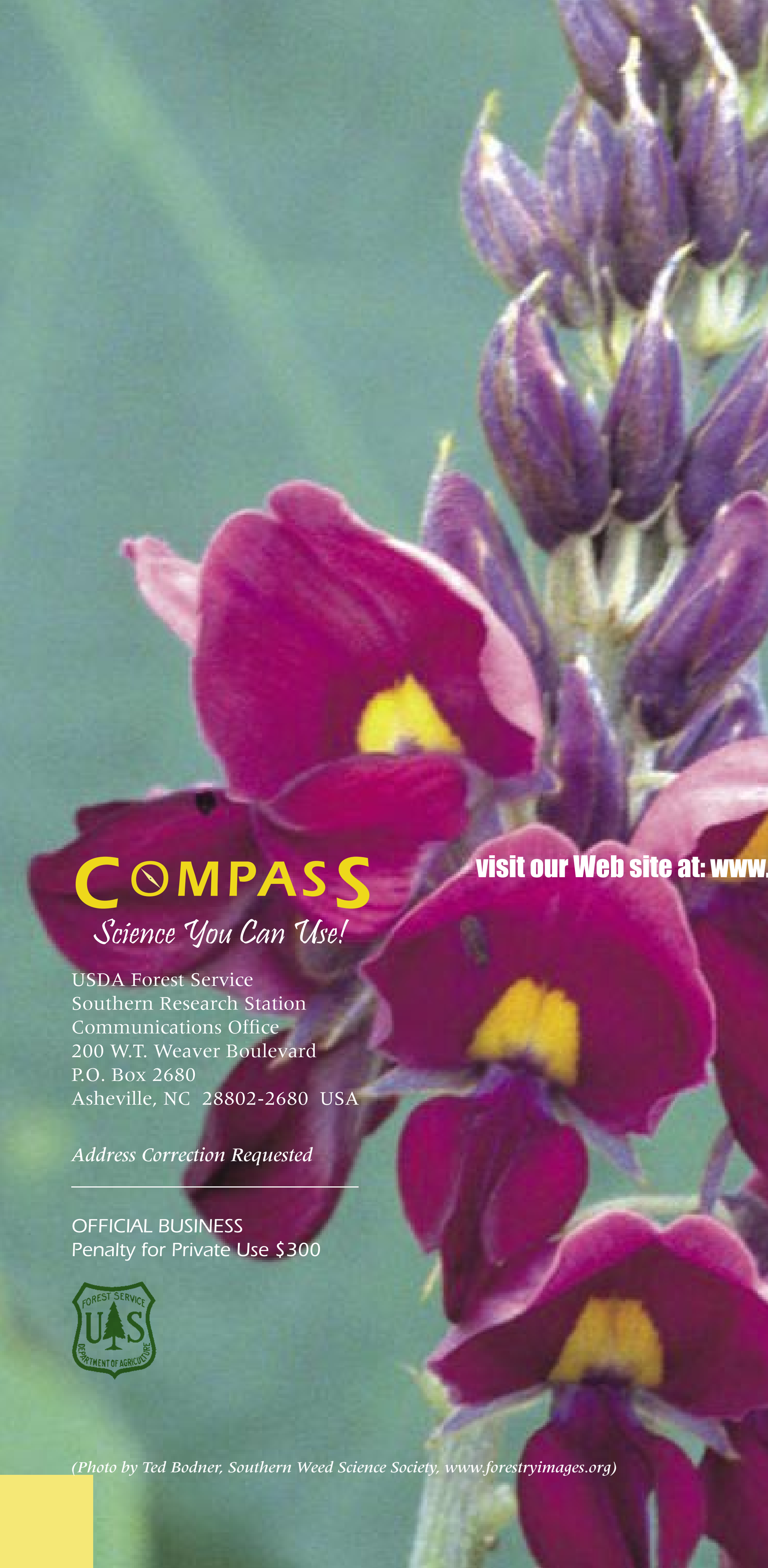

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